

Diplazium delitescens and the Neotropical Species of Asplenium sect. Hymenasplenium

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Since the original description of *Diplazium delitescens* Maxon, no one has seriously questioned its generic disposition. However, a preliminary study of herbarium material of this uncommon neotropical species suggests that it might be better placed in *Asplenium*. Maxon relied chiefly on the back-to-back arrangement of linear sori in ascribing this species to *Diplazium*. In contrast, spleenworts generally have only single, linear sori on the ultimate veins. Although soral arrangement is the primary (and usually most reliable) character used to separate the two genera, I report here a survey of additional characters that provide good evidence for transferring *D. delitescens* to *Asplenium*.

Sporangia.—The species of *Asplenium* consistently have one-rowed sporangial stalks, at least at the base (Bower, 1928, p. 140; Tardieu-Blot, 1932, p. 363) and sporangial capsules that often split divaricately at the tip of the fully extended or backwardly flexed annulus. *Diplazium delitescens* possesses both these characteristics (Fig. 1). Other species of *Diplazium* have shorter, two- or three-rowed sporangial stalks, with annuli often not extended and capsules not splitting divaricately at the tip, e.g., *D. werckleanum* Christ (Fig. 2). I have been unable to find any reference to this distinctive type of sporangial opening in *Asplenium*, but I believe it may be a very useful character in distinguishing asplenioid species from other groups of ferns.

The number of annular cells in *Asplenium* is generally higher than in *Diplazium*. Tardieu-Blot (1932, p. 364) reported 15-20 annular cells for species of *Diplazium* and 20-25 annular cells for species of *Asplenium*. Copeland (1947, p. 147) listed *Diplazium* (in *Athyrium*) as having an "annulus of 12-20 (commonly 16) thickened cells," whereas *Asplenium* was described as having an "annulus usually of 20-28 cells." I have made five counts each on *A. laetum* Swartz (Breedlove 33893, DS), *A. abscissum* Willd. (Breedlove 22178, DS), *A. harpeodes* Kunze (Breedlove 22504, DS), and *A. auriculatum* Swartz (Breedlove 22506, DS); these species averaged 23, 20, 21, and 20 annulus cells per sporangium, respectively. *Diplazium franconis* Liebm. (Breedlove 22421, DS), *D. lonchophyllum* Kunze (Breedlove 22461, DS), *D. acutale* Fée (Breedlove 22760, DS), and *D. werckleanum* Christ (Breedlove 33664, DS) all averaged 15 annular cells per sporangium. *Diplazium delitescens* (Breedlove 33853, DS) averaged 21 annular cells per sporangium, which agrees with *Asplenium*.

Spores.—*Diplazium delitescens* spores have numerous, sharp folds in the perispore (Fig. 3), and are similar to, or even indistinguishable from, spores of several species of *Asplenium* from southern Mexico and Central America, e.g., *A.*

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auriculatum (Fig. 4), *A. laetum*, *A. abscissum*, and *A. harpeodes* (vouchers the same as listed above). On the other hand, *Diplazium* spores tend to have a loosely folded perispore without sharp ridges, e.g., *D. werckleanum* (Fig. 5), *D. acutale*, *D. lonchophyllum*, and *D. franconis* (vouchers the same as listed above). Although there is considerable variation in perispore morphology in both *Asplenium* and *Diplazium*, these spore characterizations are in general agreement with the illustrations of spores of the two genera in Tardieu-Blot (1932, pl. 49 and 50), Wagner (1952, pl. 5), Erdtman (1957), Nayar and Devi (1963), Nayar (1964), and Tschudy and Tschudy (1965).

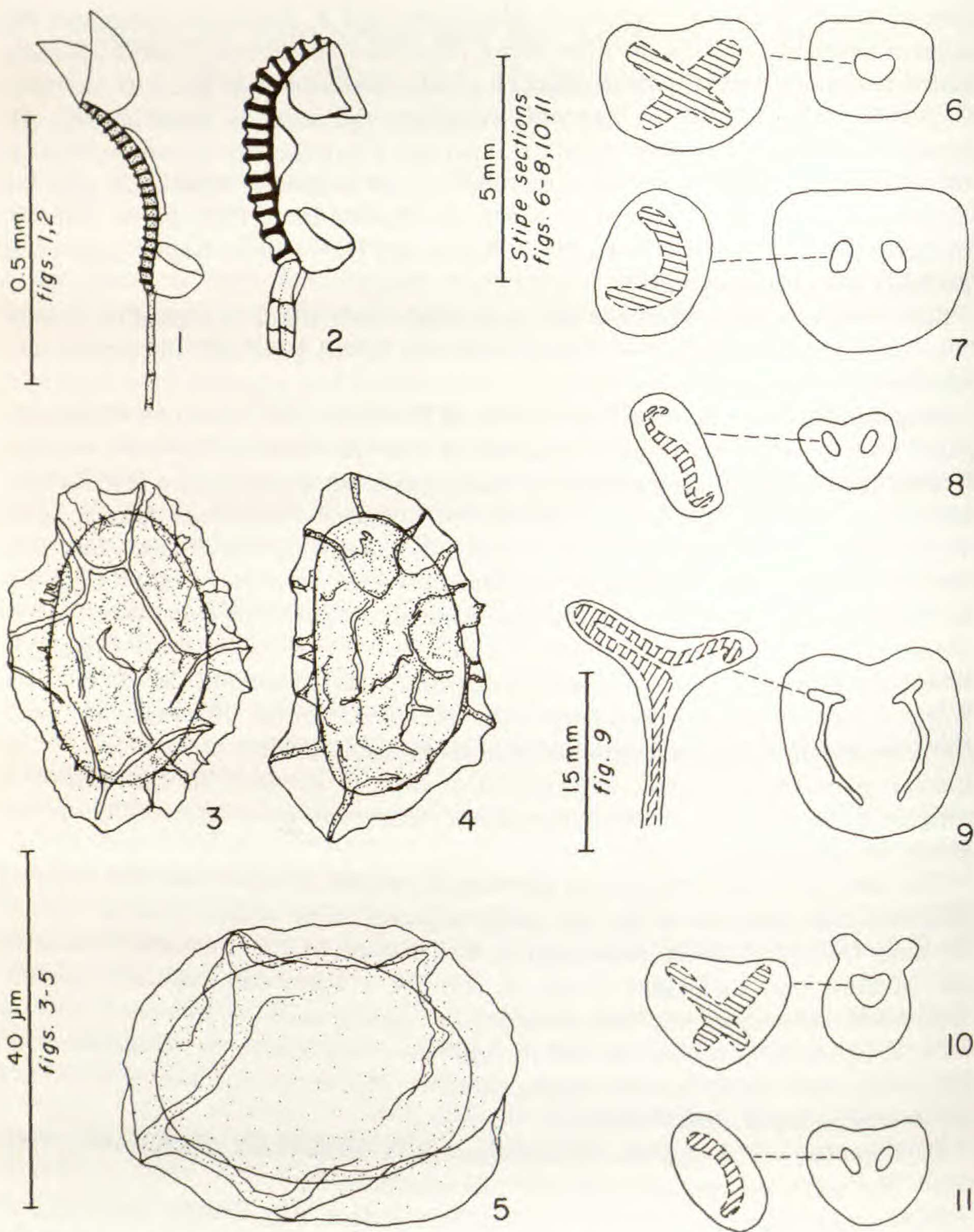
Sori.—*Diplazium delitescens* has both single sori, which is typical of *Asplenium*, and sori paired back-to-back, which is found generally throughout *Diplazium*.

Rhizome habit.—The creeping rhizome of *D. delitescens* is aberrant when compared with the suberect to erect rhizomes of other neotropical *Diplazium* species. Repent rhizomes are also unusual in *Asplenium*, but do occur in a few species, namely, *A. obtusifolium* L., *A. repandulum* Kunze, *A. hoffmannii* Hieron. (syn. *A. membranifolium* Maxon), *A. melanopus* Sod., and *A. laetum* Swartz, as well as the Old World species belonging to *Asplenium* sect. *Hymenasplenium* (Hayata) K. Iwats. (Iwatsuki, 1975). According to Iwatsuki, this section comprises five Old World species (*A. unilaterale* Lam., *A. excisum* Presl, *A. subnormale* Copel., *A. obscurum* Blume, and *A. cheilosorum* Kunze ex Mett.) and possibly a few New World ones. Iwatsuki believes that the dorsiventral rhizomes of sect. *Hymenasplenium* are an adaptation to a rocky habitat. Most of these Old World species grow on wet rocks adjacent to or even in streams; the one exception appears to be *A. excisum*, which Iwatsuki believes to grow terrestrially on rich humus in deep forest.

The habitat favored by several neotropical species of *Asplenium* with creeping rhizomes also appears to be wet rocks adjacent to or within streams. This is certainly true of *A. obtusifolium* and *A. repandulum*, at least in southern Mexico; see Morton and Lellinger, (1966, p. 12) for a somewhat different opinion. *Asplenium melanopus* has been recorded as "among rocks of streambed" (Mexico 6223, UC). *Asplenium laetum* and *A. hoffmannii* are apparently terrestrial or on wet rocks often near, but not within, streams. Precise habitat information is not yet available for *D. delitescens*.

Phyllopodia.—The species of *Diplazium* lack phyllopodia. *Diplazium delitescens*, like some species of *Asplenium*, has phyllopodia.

Stipe vasculature.—*Asplenium* and related genera, e.g., *Diellia* and *Camptosorus*, characteristically have two traces from the rhizome stele leading to the base of the stipe which are elliptical in cross-section; each of these meristeles contains a xylem strand that is C-shaped in cross-section. These two traces may unite in the cortex of the rhizome (below the stipe), in the stipe base, or midway up the stipe to form a distinctive xylem strand that is X-shaped in cross-section (Ogura, 1972; Bir, 1970; Wagner, 1952, p. 82; Tardieu-Blot, 1932, pl. 40-42). Among neotropical species, I find this familiar X-shaped vascular pattern in the stipe bases of *A. tuerckheimii* Maxon (Fig. 6), *A. abscissum* Willd. (*Bourgeau s. n.*,



Sporangia, spores, and stipe cross-sections in *Diplazium* and *Asplenium*. FIG. 1. Open sporangium of *D. delitescens* (Breedlove 33853, DS). FIG. 2. Same, *D. werckleanum* (Breedlove 33672, DS). FIG. 3. Spore of *D. delitescens* (Breedlove 33853, DS). FIG. 4. Same, *A. auriculatum* (Breedlove 22506, DS). FIG. 5. Same, *D. werckleanum* (Breedlove 33672, DS). FIG. 6. Cross-section of stipe base in *A. tuerckheimii*, with enlargement of meristele (Purpus 6432, UC). FIG. 7. Same, *A. achilleifolium* (Carlson 417, UC). FIG. 8. Same, *D. ternatum* (Breedlove 32387, DS). FIG. 9. Same, *D. cf. pinatifidum*, with enlargement of portion of meristele (Mickel 3064, NY). FIG. 10. Cross-section of stipe near blade base in *D. delitescens*, with enlargement of meristele (Breedlove 29935, DS). FIG. 11. Cross-section of stipe base in *D. delitescens*, with enlargement of meristele (Breedlove 22482, DS).

UC), *A. cristatum* Lam. (Chrysler 5143, UC), and *A. harpeodes* Kunze (Papenfuss s.n., UC). Species possessing two meristemes (each with a C-shaped vascular pattern) at the stipe base are *A. achilleifolium* (Mart. & Gal.) Liebm. (Fig. 7), *A. auritum* Swartz (Gentle 6661, UC), *A. oligophyllum* Kaulf. (Hutchison 1485, UC), and *A. feei* Kunze (Purpus 7110, UC). In addition, all the Asian species I examined of *Asplenium* sect. *Hymenasplenium*, which included *A. obscurum* (Rodin 8128, UC), *A. excisum* (A. C. Smith 5783, UC), *A. subnormale* (Sachalian s.n., UC), and *A. cheilosorum* (Copeland 163, UC), have in cross-section two elliptic meristemes with C-shaped strands in the stipe base.

The species of *Diplazium*, like those of *Asplenium*, usually have two vascular strands in the stipe bases; these strands remain separate for most of the stipe length, but towards the apex unite to form a bundle that is gutter- or U-shaped in cross-section (Ogura, 1972; Bir, 1962; Tardieu-Blot, 1932, pl. 36 and 37). On the other hand, the X-shaped xylem patterns of *Diplazium*, unlike those of *Asplenium*, have pronounced hooks at their adaxial ends and, to a lesser extent, at their abaxial ends (the hippocampus-shaped bundles of Ogura, 1972). I have observed hippocampus-shaped xylem strands in the following New World species: *D. ternatum* Liebm. (Fig. 8), *D. cf. pinnatifidum* Kunze (Fig. 9), *D. obscurum* Christ (Mickel 3010, NY), *D. seemannii* Moore (syn. *D. macrotis* (Baker) Christ, Mickel 3062, NY), *D. lonchophyllum* Kunze (Mickel 2968, NY), *D. plantaginifolium* (L.) Urban (Breedlove 31507, DS), and *D. werckleanum* (Breedlove 26827, DS). These strands apparently never have the back-to-back-C arrangement characteristic of the *Asplenium* vascular pattern. The larger species of *Diplazium* tend to have somewhat more elaborate strands (Bir, 1969). However, differences in stipe vasculature are not simply a function of stipe size, for the stipes of *D. ternatum* and *D. plantaginifolium* have a smaller diameter than do those of many *Asplenium* species examined in this study.

Stipe vasculature in *D. delitescens* is much more like that in *Asplenium* than that in *Diplazium*, and matches closely the vasculature of species belonging to *Asplenium* sect. *Hymenasplenium*: two elliptical bundles fuse high in the stipe to give the asplenioid X-pattern (Figs. 10 and 11).

Rhizome scales.—In general, *Asplenium* is characterized by having clathrate scales, with dark, lateral walls and clear, often transparent lumina; in *Diplazium*, the lumina show little contrast with the lateral walls, and are usually brownish, apparently never transparent (Tardieu-Blot, 1932, p. 357). The stipe base scales of *D. delitescens* are clearly clathrate, although this condition is not so obvious as in many spleenworts because the scales are few, narrow, and often dirt-covered. The lumina are nearly transparent, with thick and dark lateral walls.

Chromosome number.—Chromosome number should provide a means of placing *D. delitescens*. Nearly all *Asplenium* species have a base number of $x=36$, with *A. unilaterale* (sect. *Hymenasplenium*) counted several times as $n=40$. The only count available for a New World *Asplenium* with a creeping rhizome is $n=36$ for *A. laetum*. *Diplazium* species consistently have $x=41$.

On the basis of the aforementioned characters, I believe that *D. delitescens* is best treated as a member of *Asplenium*, probably most closely related to species in

sect. *Hymenasplenium* (Hayata) Iwatsuki:

***Asplenium delitescens* (Maxon) A. Reid Smith, comb. nov.**

Diplazium delitescens Maxon, Contr. U. S. Nat. Herb. 10: 497. 1908. TYPE: Vicinity of S. Luis, Pcia. Oriente, Cuba, Pollard & Palmer 348 (US).

The neotropical species of *Asplenium* sect. *Hymenasplenium* appear to be: *A. delitescens*, *A. hoffmannii*, *A. laetum*, *A. melanopus*, *A. obtusifolium*, and *A. repandulum*. *Asplenium melanopus*, known from Colombia to Peru, has often been treated as *Diplazium melanopus* (Sod.) Hieron., but was first described in a broadly circumscribed *Asplenium* that included *Diplazium*. *Asplenium melanopus* appears to be most closely related to *A. laetum*, but it may also have affinities to *A. delitescens*. Another species of this group may be *Asplenium purpurascens* Mett. ex Kuhn, based on a type from Ecuador, which is described as having a creeping rhizome; I have seen too little material to place it here with certainty.

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